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ABSTRACT

Merging the instructional implications drawn from theory and research in the interactive reading model, schemata, and metacognition with computer based instruction seems a natural approach for actively involving students' participation in reading and learning from text. Computer based graphic organizers guide students' preview or review of lengthy readings. The grapic preorganizers present visual displays of key terms and concepts arranged diagrammatically to depict the major concepts so that the organizational pattern can be identified in a way that relates the new information to existing schema. Postorganizers encourage students' self-interrogation of their ability to reorganize, consolidate, and review the text content just read. With the use of computer based glossing, the reader sees no gloss notations until the computer is signalled through a HELP command to present one. At the same time, the reader is constantly involved in metacognitive decision making about which gloss notations might have to be signalled to gain or maintain understanding. Other features of the glossing system are a statistics file that allows for the administration of consistent directions and collection of accurate data, and a text-authoring system that allows noncomputer-oriented teachers to build their own computer based glossing activities to promote comprehension strategies. (HOD)

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I Use the Computer to ADVANCE Advances in Comprehension-Strategy Research

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Related Paper for "Cognitive Factors Related to Reading Comprehension" Session at the University of Wisconsin Symposium: Factors Related to Reading Performance

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Running Head: Advancing Comprehension Through CBI

I Use the Computer to Advance ADVANCES in Comprehension-Strategy Research

"What could be more practical than a good theory of reading comprehension?" goes the question. "The application of good theory into planning meaningful comprehension instruction," goes the answer--especially when the theory provides sound foundation for on-going research to determine its effectiveness to explain and predict the useful results of that instruction. This paper represents my attempt to synthesize implications for instruction gathered from several current theories and related research for the purpose of developing computer-based instruction which improves content-area readers' ability to comprehend and learn from text. I have drawn from the interactive model of reading (Rummelhart, 1976), schema theory (Rummelhart & Ortony, 1977) and metacognition (Brown, 1980) to experiment with the development of computer-based instruction for promoting the use of comprehension skills and strategies to read and learn from text.

Theory and Research Related to Comprehension

Theory. The interactive reading model involves both the reader and the text working in concert to unlock meaning (Strange, 1980). "Top-down" processing--where the reader comprehends by bringing more information to the text (prior knowledge) than the text brings to the reader--is synthesized with "bottom-up" processing--where the reader comprehends by

gathering low-level information (letters features, letters) to higher-level encodings (word groups, word group meanings). Top-down and bottom-up processing converge to enable the reader to determine the author's overall intended meaning and to spark some unique critical reactions to that overall meaning. [See Rystrom (1977), Strange (1980) and Jones (1982) for excellent examples which illustrate top-down and bottom-up processing.]

Schema theory expands the interactive model by attempting to explain how new information acquired while reading becomes integrated with old information already in the reader's head--in memory structures, called "schemata" (Rummelhart, 1977). Schemata is assumed to contain slots--such as objects (e.g., toys, vehicles), episodes (e.g., buying a suit, eating spaghetti), and events (e.g., birthdays, parades)--that become filled accordingly to the information presented in the text. Reading comprehension results when the slot in the schemata correspond appropriately to the printed information and, thereby, changing and expanding the schemata. [See Rummelhart & Ortony (1977), Anderson (1977), Anderson, Spiro, & Anderson (1977), and Spiro (1980) for further explanation about schema theory.]

A third theoretical area in the study of reading and cognition that has influenced my work in the development of computer-based comprehension instruction is drawn from developmental psychology. Overlapping and expanding on the skills and strategies of gathering information from text and relating it appropriately to exisiting schemata, metacognition

involves the awareness of understanding that new information and its appopriate use. Brown (1980) refers to metacognition in reading as actively monitoring the understanding of text--and taking corrective action where necessary--and judging it against criteria set as the purpose for reading. In otherwords, the reader draws on his/her schemata (prior knowledge) and interactive reading strategies in light of his/her purposes established to determine how to read and how closely to monitor understanding to meet those purposes. Brown lists seven examples of reading/study strategies which she believes involve metacognitive decision-making (and include many of the major aspects of the interactive reading model and schema theory as well):

1. clarifying the purposes of reading, that is, understanding the task demands, both explicit and implicit;
2. identifying the aspects of a message that are important;
3. allocating attention so that concentration can be focused on the major content area rather than trivia;
4. monitoring ongoing activities to determine whether comprehension is occurring;
5. engaging in review and self-interrogation to determine whether goals are being achieved;
6. taking corrective action when failures in comprehension are detected; and
7. recovering from disruptions and distractions--and many more deliberate, planful activities that render reading and efficient information-gathering activity (p. 456).

Research. Much of the experimental research conducted in reading comprehension has been focused either on the reader or the text. Implications for hypothesis-testing the interactive reading model, schema theory and the metacognitive construct are that the attention of the instructor/experimentor be focused directly on the interaction of reader and text. Two areas of experimental research dealing with this interaction have provided the data-base for rationalizing the development of computer-based applications: research on graphic advance organizers and research on glossing.

The graphic advance organizer, as conceptualized by Estes, Mills, and Barron (1969), draws especially on schema theory as an instructional technique to aid the reader in relating new information and concepts to existing knowledge. Whether employed as a pre-, during- or post-reading instructional device, graphic organizers are designed to provide the reader with a visual and verbal representation of the key vocabulary of the text content in relation to subsuming vocabulary concepts the reader has already learned. Although the results of investigations to determine the effectiveness of graphic organizers have been inconclusive (Otto, White & Camperell, 1980), recent experiments have favored the graphic organizer over other treatment or control conditions. Walker (1979), Dana (1980) and Alvermann (1980) have found significant differences favoring the use of graphic organizers, particularly when the text is lengthy and when the content includes more than one theme.

Perhaps the most elaborate recent instructional research effort made to synthesize the theoretical aspects of interactive reading, schema theory, and metacognition has been in the area of glossing expository text. Gloss is generic term which refers to marginal or intratext notations which are constructed by the teacher to actively direct readiers' attention while reading to passages where specific skills (e.g., paraphrasing) and strategies (e.g., monitoring comprehension) can be applied to comprehend and learn from content-area text. Glossing, as an instructional technique, could provide the teacher with a practical means for guiding the reader when the two are apart from each other to both promote the reader's acquisition of text content and draw attention to the necessity of applying bottom-up and top-down strategies consistent with (metacognitive) awareness of appropriate existing schema to interpret meaning. Results of pilot studies conducted by Wilkie (1978) and Witte (1980) and evaluations conducted by Camperell (1980) and Young (1980) have helped to establish the gloss technique as a palatble, systematic and useable both to teachers and to students. [See Otto, White & Camperell (1980) for a detailed description of gloss with examples.]

Computer-Based Reading Instruction

Merging the instructional implications drawn from theory and research in reading comprehension with computer-based instruction seems a natural one for actively involving students' participation in reading and learning from text. In this

section, the three basic types of computer-based instruction will be briefly overviewed with reference made to relevant research conducted tp promote reading ability. Then I will describe, with examples, several applications of computer-based instruction I have devised to promote the use of comprehension strategies with students enrolled in my college reading methods courses.

Types of Computer-Based Instruction. Presently, the greatest use of computer-based instruction is drawn from the technology of classical programmed instruction for skill-and-practice; that is, it emphasizes the bottom-up processing aspect of interactive reading while ignoring the top-down aspects of the model. Briefly, the basic unit of the programmed instruction is the "frame." A frame usually consists of a television screen display which request a response from the user (learner). When a response is made, feedback from the computer data-bank is given. If the response is appropriate, the learner is guided to the next hierarchical frame. If not, the learner is guided through a feedback loop to a frame which explains and/or restates the same request (Doublier, 1974). Extensive surveys of experiments comparing the effectiveness of computer-based instruction with traditional skill-and-practice instruction have shown strong evidence for the computer-programmed approach where effectiveness is measured by standardized reading achievement tests (Vinsonhaler & Bass, 1972; Mason & Blanchard, 1979; Mayer, 1980).

A second emerging form of computer-based instruction is the

instructional game. While still emphasizing the skill-and-drill of bottom-up processing, these learning-enhancing games do begin to dabble with top-down strategies as well. And because these are game situations, the learner has more of a feeling of being "in charge" (Lesgold, 1981). A variety of game-board programs (e.g., "Beat the Clock") are commercially available which serve as effective motiviators for enticing learners to practice specific reading comprehension skills. The learner is able to dictate how difficult the game will be, how long it will run, the awards and penalties of play, and how many players (i.e., learners) may be involved. Ideally, the learner should discover improvements in the skills practiced as a result of the games. [Lesgold (1981) provides an extensive description of current computer-based instructional games.] No research results have been reported to date as to the effectiveness of computer-based instructional games.

The third type of computer-based instruction, which is probably the most complex and most promising, is the tutorial system. This type is capable of modeling and guiding the learner's knowledge (schemata) through simulated real-world reading activity and tailoring interactive reading processes (bottom-up and top-down) to enhance the learner's comprehension and memory of the text content. The tutorial system is also capable of recording the learner's interaction with the text while providing useful comprehension aids to identify specific skills/strategies training. And finally, the tutorial is capable

of being constructed so that a teacher with little or no knowledge of programming can build his or her own computer-based instruction for his or her own materials which is suited to an appropriate student audience. At present, some introductory research that I have conducted appears to be the only work in the literature related to reading comprehension. My experimentation with computer-based glossing (explained later in this paper) has so far shown that students receiving the tutorial system performed significantly better on a free recall measure than did students not receiving the tutorial (Blohm, 1981).

Advancing Comprehension through Computer-Based Instruction

To date, I have drawn on the instructional implications of the three comprehension theories and their related research to develop interactive computer-based graphic organizers and computer-based glossing.

Computer-based Graphic Organizers. I have utilized the classic programmed instruction type of computer-based instruction to devise computer-based graphic pre-organizers and post-organizers to guide my students' preview or review of lengthy readings assigned in my methods courses. As shown below in Figure 1, the graphic pre-organizer presents a visual display of key terms and concepts arranged in a diagrammatic to depict for the reader the major concepts from the minor ideas so that the organizational pattern can be identified along with relating the new information to existing schema. Procedure-wise, the students recieve all initial instructional directions and

assignment in class; then between class sessions, they log onto the university's central computer to recieve the graphic pre-organizer for the upcoming reading assignment.

[Insert Figure 1 about here.]

Students are asked not to read the assignment before viewing the pre-organizer. They may view the pre-organizer on the television screen for as long as they need, but they are encouraged not to copy the diagram. Rather, they are enticed to relate the key terms to their existing knowledge and predict the apparent relationships shown between the vocabulary and concepts. Class discussions and activities (such as vocabulary-building, paraphrasing) which follow from the reading are dealt with in concert with the graphic organization previewed on the computer terminal. Based on observation, student reactions to the computer-based pre-organizer have been mixed. High achievers in the course tend to find the pre-organizers less helpful for organizing the information than their <u>own</u> personal preorganization of the text content. The other students, however, find the pre-organizer a helpful aid. Since trying out the technique with the students for one semester under mandatory conditions, I now simply offer the computer-based pre-organizer to the students as an optional aid for promoting their comprehension.

I have found greater success with the development and implementation of the computer-based post-organizer. This type of organizer was designed to encourage students'

self-interrogation of their ability to reorganize, consolidate, and review (when necessary) the text content just read. Following reading, the students are required to log onto the computer project and fill in the missing key vocabulary and concepts on the partially complete graphic post-organizer. As shown in Figure 2, several key concepts which appeared in the graphic pre-organizer (Figure 1) have been replaced with blanks--similar to cloze exercises--to be typed in by the students.

[Insert Figure 2 about here.]

They can move the "cursor" (a flashing subscript line used to identify the location of the next typed character) to the start of any one of the blanks in the organizer desired to respond; order of response does not matter. Students are asked to type from memory the missing key terms to complete the post-organizer; synonym spellings and words are accepted. When all of the blanks have been filled, the students signal the computer that they are finished and want a check of accuracy. The computer program then reacts to the request by showing the whole post-organizer once more; this time, however, the successful responses made by the students are shown in reverse image on the screen to congratulate the students while inappropriate responses yield suggested pages and paragraphs/lines to re-study. Again, observation and interviews with students generally indicate that my students prefer the post-organizer to the pre-organizer for consolidating new knowledge with existing schema, for self-interrogating

reading achievement, and for making decisions about taking corrective actions when failures in comprehension are detected.

Computer-based Glossing. My attempt to date with the tutorial system type of computer-based instruction has been to refine and expand the currently designed glossing technique and its characteristics (described earlier) for operation on an interactive computer terminal. Presently, gloss notations have been constructed for paper-use by instructors with groups of readers in mind rather than the individual: that is, all gloss notations are apparently assumed necessary for all readers. My intent in the computer-based version has been to create an individualized tutorial that allows each reader to interact with text (on the terminal screen) in light of existing schemata for both the content and processes (skills and strategies), to then monitor on-going comprehension, and to decide on and take appropriate corrective action (ask for a specific gloss notation) when necessary to recover from comprehension failures. In this system, the reader sees no gloss notations until the computer is signalled through a HELP command to present one. This way, the reader is spared the disruption and distraction of unecessary glosses from which he or she must recover in order to proceed learning from the text. At the same time, the reader is constantly involved in metacognitive decision-making about which gloss notations might have to be signalled to gain or maintain understanding. Reader self-regulation, as promoted through computer-based glossing, could serve as a promising vehicle for

making the educational shift from teacher-directed instruction to student-centered learning.

The instructional process of computer-based glossing currently involves the following activities:

1. the instructor identifies (a) the text content and (b) the appropriate "amount" and "type" of gloss notations to promote purposeful comprehension;

2. the instructor develops a computer program to store the text and related gloss notations for reader use (called "courseware");

3. the reader operates (runs) the courseware program (i.e., reads the text with the related glosses only when necessary) on the computer terminal screen;

4. the courseware program interacts with the reader for the following purposes--

   a. to simulate a real-world reading-for-learning environment,

   b. to provide specific and individualized tutorial gloss notations to the reader when requested,

   c. to profile the reader's cognitive behavior with the courseware (i.e., record each gloss notation requested by type and content relationship along with reading rate-per-page), and

   d. to develop a group summary file for statistical analysis to study the effectiveness of the courseware.

An example of a typical screen page of text assigned in my methods course as part of the students' computer-based glossing activity is illustrated below in Figure 3.1.

[Insert Figure 3 about here.]

The number above the first word in each sentence and symbols above the each key concept or term represents "codes" for commanding specific gloss notations from the computer. If a

reader signalled HELP for a "paraphrase" gloss of Sentence 1 and a "definition" gloss for the term, 'discourse', in Sentence 3, the terminal screen page would reappear (see Figure 3.2) with the requested gloss notations either replacing or expanding the original print in context with the surrounding base information. Directions for identifying and using the codes to command HELP from the computer precede each computer gloss activity along with practice examples. As the reader continues through the courseware, a page-by-page reading rate is noted and recorded along with any gloss requests made (by skill and/or strategies). Following the reading of the entire selection, the reader is shown his or her personal reading profile for that assignment to diagnose any possible need for skills and strategy training.

Student reactions to the few computer-gloss reading assignments have been as encouraging and as parallel in response as the results of my initial research investigation. With the added features, such as backpaging, the students seem to be very interested in the courseware's capabilities. Again, the high achievers report using fewer gloss notations than do the average and below achievers (verified by examining the summary file). The high achievers were relieved when I congratulated them on their metacognitive decision-making. With more practice, the students generally feel that the approach could actually save them study time. (My research study showed that no extra time was necessary to learn from text on a terminal while employing computer-based glossing.)

An important feature of the computer-based glossing system is the summary "dump-statistics" file. This cumulative file, along with the directions and practice exercises, serves me well as a "research assistant" for hypothesis-testing the constructs of the interactive reading model, schema theory and metacognition. Administration of consistent directions and collection of accurate data allow me to study the instructional effects of the system as data come in. This unobtrusive measurement technique may possess the potential to replace existing diagnostic techniques by completing accurate diagnostic pupil profiles for identifying specific remedial training to be corrected in the regular classroom with appropriate content-area materials. Researching skills hierarchies and identifying the optimal skills of "good" readers versus poor readers may also be more reliably examined through computer-based glossing since readers will "act upon" the text rather than be "acted upon" by the researcher.

And finally, the instructional framework for developing computer-based glossing courseware provides one other possibility to noncomputer-oriented teachers: a programming "text-authoring" system that will allow them to build their own computer-based glossing activities to promote comprehension strategies. I am currently working with a graduate assistant in the Home Economics Department who is creating a computer-based glossing courseware package for her undergraduates in a clothing course. With no background at all in computers, she has

demonstrated relative ease in plugging the appropriate text and glosses into the appropriate files of the courseware. Our major effort has been directed toward development of appropriate gloss notations in light of her established expectations. And that's as it should be! Computer technology should serve us as a vehicle for identifying, developing and integrating appropriate comprehension skills and metacognitive strategies into real-world reading settings.

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GRAPHIC PRE-ORGANIZER

This graphic organizer is designed to provide you with some advance STRUCTURE for new VOCABULARY and CONCEPTS that will be introduced and described in this reading assignment.

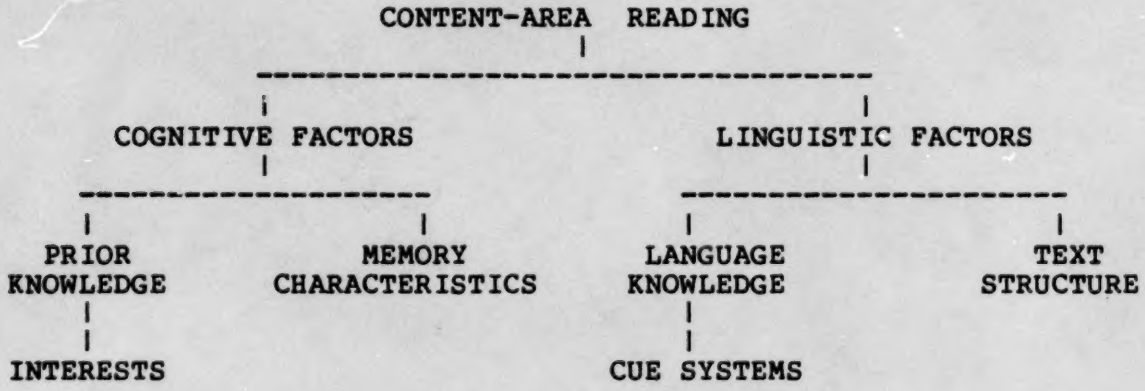

Figure 1. Example of computer-based graphic pre-organizer.

GRAPHIC POST-ORGANIZER

This graphic post-organizer is designed to allow you to check your MEMORY of the key VOCABULARY and CONCEPTS presented in this reading assignment. Move the cursor to each blank and type in a word or phrase that you feel belongs in that category. DON'T LOOK BACK INTO THE TEXT!!

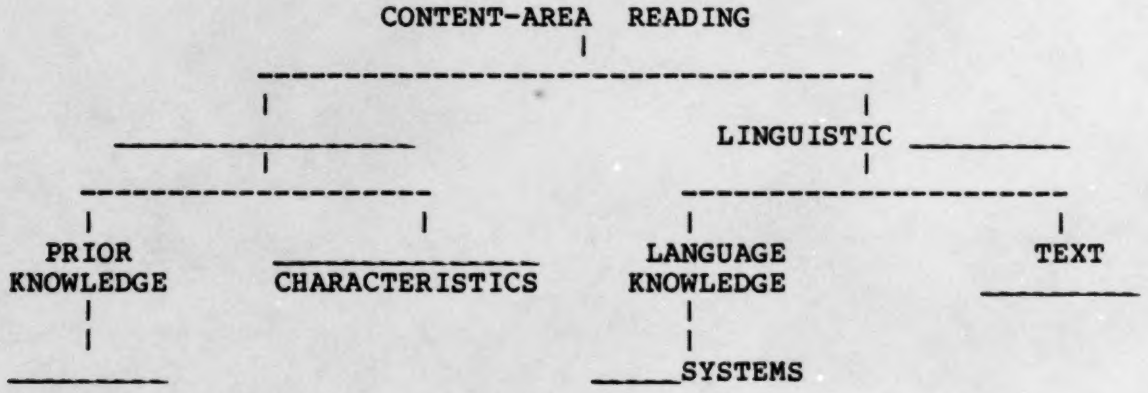

Figure 2. Example of computer-based graphic post-organizer.

3.1. Original version of screen text

1
One of the most universal findings to emerge from recent
<
psycholinguistic research is the marked degree to which a learner
>
applies prior knowledge of a topic to facilitate future cognition.
2 <
In fact, most contemporary delineations of comprehension allude to
the role of prior knowledge as a "yellow brick road" to compre-
* 3
hending written discourse. Recent experiments conducted by cogni-
tive psychologists provide explicit demonstration of the prominent
4
role prior knowledge plays in text comprehension. For example,....

3.2. Glossed version of screen text

1
One of the most universal findings to emerge from recent
<
psycholinguistic research is the marked degree to which a learner
>
applies prior knowledge of a topic to facilitate future cognition.
IN OTHERWORDS, THOSE WHO STUDY THE PSYCHOLOGY AND LINGUISTICS OF READING HAVE FOUND THAT WE USE KNOWLEDGE WE ALREADY HAVE TO GAIN UNDERSTANDING OF NEW INFORMATION WE IDENTIFY IN OUR READING.
2 <
In fact, most contemporary delineations of comprehension allude to
the role of prior knowledge as a "yellow brick road" to compre-
*
hending written discourse [THE IDEAS CONTAINED IN THE TEXT].
3
Recent experiments conducted by cognitive psychologists provide
explicit demonstration of the prominent role prior knowledge plays
4
in text comprehension. For example,....

Figure 3. Example of computer-based original and glossed text.